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WILLIAM HARKNESS.

PROFESSOR WILLIAM HARKNESS, U.S.N., whose name has been identified with the work of the United States Naval Observatory for nearly forty years, died in Jersey City, N. J., February 28, 1903.

On his retirement for age from active service in December, 1899, he went to his home with the intention of returning to Washington, after a short rest, for the purpose of devoting his well-earned leisure to scientific work which the press of official duties had prevented him from completing. An attack of nervous prostration obliged him to defer returning to Washington until he should recover sufficient strength. Month by month he expressed his expectation soon to be strong enough to return, but he never recuperated sufficiently to carry out his cherished plans. Weakness of body confined him quite closely to the house, so much so that he dared to venture on the street not more than half a dozen

times during the last three years. The immediate cause of his death was Bright's disease, which fastened itself upon him during the last few months of his life.

The following biographical memorandum prepared by Professor Harkness' own hand gives an accurate statement in a condensed form of the facts of his education and his career. This statement is all the more interesting because the writer indicates clearly the discoveries and achievements which he deemed notable and important. A. N. Skinner.

BIOGRAPHICAL MEMORANDUM.

Harkness (William), son of Rev. Dr. James and Jane (Weild) Harkness, born at Ecclefechan, Scotland, December 17, 1837; height, 5 feet 10.0 inches; average weight, 185 pounds; circumference of head, 23.0 inches; cephalic index, 0.733. Entered Lafayette College, Easton, Pa., in 1854, but owing to the removal of his parents to Rochester, N. Y., became a student in Rochester University in 1856, and graduated with the degree of A.B. in 1858. From Rochester he also received the degree of A.M. in 1861, and LL.D. in 1874. From Lafayette he received the honorary degree of A.M. in 1865. Studied medicine in New York, and received the degree of M.D in 1862. Was reporter in the New York Legislature for the Albany *Atlas and Argus* in 1858, and in the Pennsylvania Senate for the Harrisburg *Daily Telegraph* in 1860. Appointed from New York as aid at the United States Naval Observatory August 1, 1862. Served as surgeon at the second battle of Bull Bun, August 30, 1862. Commissioned professor of mathematics in the Navy with the relative rank of lieutenant-commander, August 24, 1863, and served at the Naval Observatory until October 4, 1865. Served with the Army during Early's attack on Washington, July 11–12, 1864. Served on the United States monitor *Monadnock* from October 17, 1865, to June 28, 1866, making exhaustive observations on the behavior of her compasses under the influence of the heavy iron armor of the ship, and also completely determining the terrestrial magnetic declination, inclination and horizontal force at all the principal ports visited during the cruise, which extended from Philadelphia to San Francisco, *viâ* the Straits of Magellan and the western passages on the coast of Patagonia. This was the most elaborate discussion of the behavior of compasses on armored ships which had been made up to that time, and all the magnetic work of the cruise was published by the Smithsonian Institution in 1871, forming a large quarto volume of 225 pages. During this cruise the *Monadnock* was present at the bombardment of Valparaiso by the Spanish fleet, March 31, 1866, and also at the bombardment of Callao by the same fleet on May 2, 1866. From San Francisco Professor Harkness traveled across the continent to Omaha, partly by military transportation and partly by stage-coach, the Pacific railroad not having been built at that time. Upon returning to Washington he was attached to the Hydrographic Office from October 14, 1866, until October 1, 1867, and to the Naval Observatory from October 1, 1867, until May 30, 1874. Observed the total solar eclipse of August 7, 1869, at Des Moines, Iowa, and there discovered the now famous coronal line *K* 1474. Observed the total solar eclipse of December 22, 1870, at Syracuse, Sicily, and before returning to the United States visited nearly all the principal European observatories, including Greenwich and Pulkowa. November 13, 1871, was appointed one of the original members of the United States Transit of Venus Commission, to arrange for observing the transits of Venus in 1874 and 1882.

Took part in all the deliberations of the commission, devising most of the instruments used by the observing parties, and was actively engaged for more than two years in fitting out the various United States expeditions. Attained the relative rank of commander May 31, 1872. Was attached to the United States steamer *Swatara* from June 3, 1874, to June 3, 1875, during her voyage to the southern hemisphere with the United States transit of Venus parties, and visited all the points at which she touched. His own station was at Hobart, Tasmania, and after successfully observing the transit of Venus there on December 9, 1874, he accompanied the *Swatara* to the German transit of Venus station on Auckland Island, in latitude 50° 56′ S., and to the United States station on Chatham Island, and finally left her at Melbourne, returning to Washington *viâ* the Hawaiian Islands and San Francisco, thus making a complete tour around the world. On June 22, 1875, was assigned to special duty at the Naval Observatory in connection with the reduction of the observations made by the United States transit of Venus parties. The records obtained by them consisted principally of wet collodion photographs upon glass plates, showing an image of the sun about four inches in diameter, with Venus upon it, and the problem before Professor Harkness was to devise instruments and methods for measuring these photographs which would give the relative positions of Venus and the sun with the utmost accuracy. This he accomplished in an entirely satisfactory manner, although the difficulty of the problem was so great that the most eminent astronomers of England and Germany failed to obtain any useful results from the photographs taken by their parties. While engaged upon the transit of Venus reductions, in 1877, he invented the spherometer caliper, which is probably the most accurate instrument known for determining the figure of the pivots of astronomical instruments, and in 1879 he discovered the theory of the focal curve of achromatic telescopes, which is now universally used for exactly defining their color corrections. In April and May, 1876, he set up the government astronomical exhibit at the Centennial Exposition in Philadelphia, Pa. Attained the relative rank of captain April 17, 1878. Observed the transit of Mercury of May 6, 1878, at Austin, Texas, and the total solar eclipse of July 29, 1878, at Creston, Wyoming, having charge of the United States Government parties at these places, and subsequently edited the quarto volume of 430 pages containing the reports on the eclipse, which was issued by the Naval Observatory in 1880. Immediately thereafter he took up the photographic observations of the transit of Mercury, and they were reduced under his supervision in 1880 and 1881. At the same time he also carried out some rather extensive experiments in astronomical photography, including the spectra of the sun and moon, with the view of ascertaining the most suitable kind of pyroxyline, and the best form of apparatus for photographing the corona during total solar eclipses. In 1881 to 1883 he was engaged in reducing the zones of stars observed by the late Captain James M. Gilliss, at Santiago, Chile, during the years 1849–52; but that work was suspended for want of funds on June 30, 1883, and was not completed and published until 1895. On account of the failure of the English and German astronomers to obtain any satisfactory results from their photographs of the transit of Venus of December, 1874, they decided not to employ photography in observing the transit of December, 1882, and a very prominent American astronomer urged the United States Transit of

Venus Commission to pursue the same course. To combat that idea, Professor Harkness published an elaborate paper 'On the Relative Accuracy of Different Methods of Determining the Solar Parallax,' which was immediately translated and reprinted in France, with the result that both the United States and France decided to continue the use of photography. In 1882, as the principal executive officer of the United States Transit of Venus Commission, Professor Harkness fitted out all the United States Government parties for observing the transit which occurred on December 6, of that year, and observed it himself at a station established on the grounds of the Naval Observatory, Washington, D. C. The work of reducing all the observations obtained by the various parties was assigned to him, and with the aid of a small corps of assistants he completed it in a little more than six years, the final result for the value of the solar parallax from the photographs being obtained on February 13, 1889. During the years 1889 and 1890 he devoted much time to the preparation of his work on 'The Solar Parallax and Its Related Constants,' which was published in 1891, and from that date until December, 1899, he was principally occupied with matters relating to the building of the new Naval Observatory, in devising and mounting its instruments and apparatus, and in establishing a proper system of routine observing. In 1891 he drew up the specifications for the construction of the 12-inch equatorial telescope, and for the repairing and remounting of the 26-inch equatorial telescope, the 8.5-inch transit circle, the meridian transit instrument and the prime vertical transit instrument. In 1894 he prepared detailed specifications for the construction of the 6-inch steel transit circle, and in 1895–96 he arranged all the details for the construction of the 5-inch steel alt-azimuth instrument. All these instruments are now mounted in the new Naval Observatory, and their principal parts are proportioned in accordance with general formulæ which Professor Harkness deduced from an examination of the drawings and specifications of nearly all the large instruments which have hitherto been constructed for the great observatories of the world. Among the novelties introduced in these instruments by Professor Harkness may be mentioned the dials which face the observer when using the quick motions of the equatorial telescopes, and constantly indicate the exact right ascension and declination of the points in the heavens to which these telescopes are directed, and the construction of the 6-inch transit circle and the 5-inch alt-azimuth instrument entirely of steel, including the telescope tubes and their axes, which are machined both inside and out, so as to reduce flexure to a minimum. On October 21, 1892, Professor Harkness was appointed chief astronomical assistant to the Superintendent of the Naval Observatory, and on September 21, 1894, he was appointed Astronomical Director of the Naval Observatory, with complete control of all its astronomical work. In addition to the astronomical directorship, he was appointed Director of the Nautical Almanac on June 30, 1897, and both of these offices he held until his detachment from all duty on December 15, 1899, preliminary to his retirement for age on December 17, 1899, when he was promoted to the rank of rear-admiral.

Professor Harkness has published many scientific papers, and is a member of numerous scientific societies. He was president of the Washington Philosophical Society in 1887, vice-president of the American Association for the Advancement of Science in 1881 and 1885, and its president in 1893.